III. *A Migration of Yellow Butterflies* (Catopsilia statira) *in Trinidad.* By C. B. Williams, M.A., F.E.S.

[Read March 5th, 1919.]

Plates VI–X.

Introduction.

In a recent number of the Transactions of the Entomological Society (1917, p. 154) I described several migrations of yellow butterflies in British Guiana, most of the records relating to *Callidryas eubule*. In October of this year I have been again fortunate enough to witness a migration of butterflies of a different species, this time in the Island of Trinidad, and on a scale larger than anything I had previously seen. The migration lasted more or less continually for nearly three weeks, and many millions of butterflies must have passed over the western half of the Island, to which district most of my records refer. With the kind assistance of a number of friends and correspondents I was able to collect over two hundred separate records of the one migration, and the results of these are given below.

Even with this large number of records, no claim can be made to completeness, and data are sadly lacking for the eastern half of the Island, which is thinly populated.

Description of Locality.

Trinidad is an Island situated just north of the mouth of the Orinoco River, and is about fifty miles in a north to south direction, and about seventy miles in extreme width. At both the north-western and south-western corners a long promontory runs out towards the mainland of Venezuela. The north-western corner is about fifteen miles from Venezuela, but the gap is partly bridged by a series of islands, and the greatest open sea space is about eight miles. At the south-western corner the distance to the mainland is only about seven miles.

Three ranges of hills run from east to west across the Island, that along the northern coast rising in places to over three thousand feet above sea-level; the central and southern ranges, however, are much lower, seldom

rising above a few hundred feet. There is no accurate map of the contours of the Island, but the first small map on Fig. I shows approximately the positions of these three ranges.

The climate of the Island is tropical, average day temperature above 80°, and the year is divided into one wet and one dry season. In general the dry season lasts from the middle of January to the middle of May, and the wet season from June to December.

The average yearly rainfall is about 65 inches, of which August averages 9·8 inches and September 7·2 inches. There is occasionally a spell of dry weather about September, forming what is known as the "Indian summer," and it should be noted that in the present year (1918) this has been particularly well marked. During the six weeks previous to the migration to be described below the weather had been unusually dry, many localities recording less than three inches for September, and in the extreme south-west scarcely any rain fell for six weeks.

The prevailing wind is the east or north-easterly trade wind.

Methods of Recording.

It has been thought unnecessary to give in detail the numerous records which were collected. Instead they have been transferred to the accompanying series of maps by a system of arrows, crosses, and circles representing, respectively, movements, abundance, or absence of the butterflies.

By referring to the maps for the 19th September to the 12th October the course of the migration day by day can be easily followed. On the larger map (Pl. X) all the records have been combined, and in addition two or three added which do not appear on the first series; these being records in which the locality and direction was given but the exact date could not be ascertained.

The signs used on the maps are as follows:—

(1) *Arrow with one head*: Very slight migration, one or two per minute within sight of the observer. Only noticeable with special care. Probably not recorded except by skilled observer.

(2) *Arrow with two heads*: Three or four butterflies per minute passing across one hundred yards line; easily noticeable to a skilled observer, and probably seen by any

average person who is on the look out; most obvious in large open spaces.

(3) *Arrow with three heads*: Distinct migration anything from ten to two or three hundred per minute crossing a hundred yards line—obvious to any ordinary person. Probably recorded by a naturalist.

(4) *Arrow with four heads*: Thick clouds of butterflies—thousands in a small space—" several with one sweep of the net "—" like snow storm "—" motor-cars held up " —gets into the local newspapers.

(5) *The series of crosses* with one, two, three and four bars represents the same scale of abundance as the arrows, but denotes that the insects were at rest or fluttering round and not moving regularly in one direction.

(6) *The circle* indicates that no butterflies were seen either moving or at rest by a reliable observer.

(7) *Circle with enclosed cross* indicates that the butterflies, if present, were not in sufficient numbers to attract attention. They are used chiefly in the case of non-entomological correspondents reporting that nothing unusual was happening in their district.

It must be absolutely understood that the blank on the maps does *not* indicate an absence of butterflies, but merely an absence of records.

These signs have been found so convenient in the present case that it is hoped that future observers will adopt some similar method of expressing their results.

The Migration.

Following the series of maps on Plates VI–IX the course of migration will be seen as follows:—

At the end of August the butterflies were reported in large numbers settling on the roads in the south-eastern part of the Island. Between this date and the third week in September no records were obtained except that on the 10th September a correspondent drove through part of the district and saw nothing unusual.

On the 19th and 20th September they are reported in numbers at rest and fluttering round in the north-eastern district, and the following day they are again abundant in the south-east (when a few were doubtfully moving northward). They had on this day started to move across the northern half of the Island at the southern edge of the northern range.

By the 22nd September the migration across the northern district had begun in earnest, and in one locality a motor-car had to stop and put down its side curtains owing to the enormous numbers of butterflies which interfered with the view of the driver.

On the 23rd they were reported in smaller numbers from the same district, and on the 24th they had reached the eastern coast in small numbers at Port of Spain (see Plate X for localities).

The movement continued in increasing intensity past Port of Spain, and on the 27th September had become a striking phenomenon. On this day they were crossing the open Savannah in Port of Spain about mid-day at a density of up to two or three hundred per minute across a distance of one hundred yards. On the same day and on the following they were seen crossing the sea over the Island of Patos near the Venezuelan coast, and undoubtedly were reaching the mainland of Venezuela.

The 28th and 29th September were marked by rains in the northern district, and the migration fell off suddenly and became apparently much confused. On both these days a few were recorded in the fine intervals, flying in an opposite direction (eastward), but not in any large numbers, and from the 30th to the 4th October small numbers were seen flying in various directions chiefly west or south-west. Between the 5th and 7th none were recorded, on the 8th, 9th, and 10th a few were recorded flying in a southerly direction, and on the 12th October a number were seen flying over the sea in a south-westerly direction. Attention should also be drawn to the offshoot migration, in a southerly direction, from the main stream just east of Port of Spain from the 27th September to 1st October. On the first of these days they were reported as appearing suddenly in unprecedented numbers in the cocoa groves a little to the south of this.

While this migration was passing across the northern half of the Island, chiefly at the southern edge of the northern range of hills, a similar stream was also moving across the southern district in the same direction. There is, however, no record of movement here until the 26th September, which is four days after the start of the migration in the north. Migrating butterflies were recorded in great numbers, particularly in the western half of the south coast, at Palo-Seco and Erin, and in a few days the flight had become general across the south-eastern district of the Island,

reaching its height in the San Fernando district about the 30th September, and continuing in gradually reduced numbers until the 4th October, and in a few localities as late as the 12th October. The most remarkable feature of this southern flight was that in the Cedros district, which is on the northern edge of the south-western promontory near its end (see Plate X); the butterflies were flying continually and in large numbers towards the east approximately from the 26th September to the 2nd October, while at La Brea a little further north-east few were seen until the 4th October, when they were flying in numbers in the usual westerly direction.

Unfortunately there are no records for the sea passage between Trinidad and Venezuela at this point, and it is impossible to say if the butterflies went across here, as in the north, or not; but from the available facts it would appear that part, at least, on reaching the south-western extremity turned to the north and then eastwards along the coast. On the 1st of October they were seen flying in small numbers in a north-westerly direction across the sea north of this coast. These records although puzzling and contradictory are confirmed by several observers, and also by a record of a previous migration in the same district, when the butterflies flew in an easterly direction for several days (see later). During the whole period of these migrations across the northern and southern parts of the Island the east-central portion was quite free of any unusual flights.

Species Represented.

It has been mentioned above that the butterfly which was mainly responsible for this migration was not *Callidryas eubule*, which has many times been recorded as migrating, but *Catopsilia statira*, a less-known species differing from the former in that the basal portion of the wings of the male are of a more intense yellow than the outer portion.

This butterfly is, as a rule, not so common in Trinidad as *Callidryas eubule*, and Sir Norman Lamont, to whom I am indebted for the identification, had previously only taken it on a few occasions in the southern part of the Island. W. J. Kaye in his Catalogue of the Lepidoptera Rhopalocera of Trinidad (Trans. Ent. Soc. 1904, p. 205) says that it is locally very common but not general. W. Potter, a young local naturalist, says that he sees it nearly every year, and

has already seen it migrating (see below). Kaye (*l.c.*) gives the known distribution as Guiana, Brazil, Peru, Ecuador, Columbia, Panama, St. Lucia. The species has previously been recorded as migrating in Brazil by Goeldi (first printed in German in " Die Schweiz "(Zurich), 1900, vol. iv, p. 441–445, reprinted in Portuguese (? with additions) in Boletin do Museu Goeldi (Para-Brazil), iv, Dec. 1904, p. 309–316, Fig. I, II), and also by Bates and Spruce (quoted in above). My notes below are taken from the Portuguese edition of Goeldi's paper.

Catopsilia statira formed, with only occasional exceptions, the whole of the migrating bands of butterflies on the present migration. At Port of Spain, on the 27th September, I noticed that about 1 in 100 or less were a smaller whitish species, of which, however, no specimens were caught. Near Arima (further east) on the same day J. B. Rorer records that about 1 in 40 were *Callidryas philea*, a larger orange species. On the 24th September in the Caura valley in the northern range C. M. Roach records that about " 1 in 40 were a larger orange species " (probably also *Callidryas philea*). At Port of Spain Mr. T. I. Potter caught one *Callidryas eubule* among many *Catopsilia statira*, but it is possible that this was fluttering round flowers and not taking part in the general migration.

Origin and Destination of Flight.

Unless the butterflies came over to the eastern or south-eastern coast of Trinidad from Venezuela (a possible occurrence, of which, however, we have no proof owing to the absence of records from this coast), it seems likely that the swarms originated in the forests of the south-eastern and north-eastern districts of the Island.

It will be noted that they were reported as abundant in the south-eastern district as early as the end of August, and it is just possible that the flight at the end of September consisted of the progeny of these. I have no data for the life-history of *Catopsilia statira*, but according to Mr. W. Buthn *Callidryas eubule*, which is closely related, has a larval stage of ten days and a pupal stage of seven, so that a complete cycle could no doubt be passed through in a month.

A slight confirmation of this is that the specimens captured were all in very good condition as if comparatively newly emerged. But as nothing is known as to the length of adult life, or of the egg-stage, or of the time taken for a

specimen to become worn, this must be taken as a possible suggestion and not as a proved occurrence.

At the other end of their flight we have definite proof of their passage over to Venezuela via Patos on the north-west, and there can be little doubt that they also crossed at the south-western corner, where only a few miles separate the Island from the mainland. We have here, however, the confusing records of easterly flights at Cedros already referred to, but in view of the million of butterflies which passed, and of the fact that there was no general abundance of them a week or two afterwards, it is certain that the greater number must have left the Island.

There were in all seven records of flight over the sea. One on the extreme north coast, where a few were flying about a hundred yards from the shore and parallel to the coast (25. ix); one record off the north coast of the south-western promontory (1. x.), and the remainder between the north-western promontory and Venezuela on various dates.

It might perhaps be mentioned here that a resident of Patos Island reported that he had seen butterflies flying towards Trinidad, but I cannot place too much reliance on this record. It has been added to Plate X, with a query.

Speed of Flight.

The flight of butterflies on migration is always very distinct from that of those flying casually. The most noticeable characteristics are the speed and the fixity of direction. In a previous account of migration of *Callidryas eubule* in British Guiana (*l.c.*, p. 159) I estimated the rate as from twelve to sixteen miles per hour (across the wind). Several correspondents in the present case remark on the speed of flight being quite unprecedented. Fortunately an opportunity occurred to get accurate data. At Port of Spain on the 27th September the butterflies happened to be flying directly down a foot-ball field on the Savannah, the length of which was found to be 110 yards. With a stop-watch eleven butterflies were timed from one end of the field to the other by three different observers (including myself) and the following results were obtained: 12, 14, 13, 12, 13, 13, 13, 12, 14, 14, 15 seconds. This gives an average of 13·2 seconds, or 17 miles an hour.

At this rate, and in the direction they were flying, they could have reached the mainland of Venezuela two hours after leaving Port of Spain.

Relation of Flight to Wind.

It is natural that the result just obtained would be affected by the strength of the wind (at this particular time they were flying with a light wind), and it is also necessary to take into consideration the relation between the direction of the wind and that of the migration.

Wind records are kept at Port of Spain, but unfortunately the records for the 27th of September, the day the butterflies were timed, were sent away before I could obtain them. The average wind velocity at Port of Spain between 9 a.m. and 4 p.m. from the 1st to 7th October was 8 miles per hour, and as my notes record that the wind at that time was slight it was probably below this figure.

The prevailing wind in Trinidad is from the east, and as this migration was towards the west it might be thought that the wind determined the direction. In British Guiana, however, for *Callidryas eubule* it was found that the usual direction was across the wind, and there are enough individual exceptions in the present case to leave no doubt that the direction of the wind, although contributory, is not the determining factor of the direction of flight.

The following cases may be quoted :—

4.x.18. Port of Spain—no wind, flight N.W. (A. Hombersley).

27.ix.18. Guiaco—wind N.E., flight N.W. (J. B. Rorer).

12.x.18. At sea off Gasparee—"endeavouring to fly west, but owing to strong N.W. wind (15–20 m.p.h.) actual course was between S. and S.S.W." (C. P. Milne).

1.x.18. San Fernando—flying N. against the wind (P. Crato).

5.x.18. Macqueripe—"flew seaward and were blown back by the force of the wind" (local newspaper).

Mr. J. A. Bullbrook further points out that the wind cannot be the conclusive factor in the direction of flight, as when flying in hilly country they continue in the same direction down the shaded leeward side of a hill as they were flying when ascending the windward side, and that on both sides they keep about the same distance from the tops of the trees.

I can from my own observation confirm this interesting note.

Direction and Reversal of Flight.

E. Goeldi, in his account of the butterfly migration in Brazil (Bol., p. 313) comments on the contradictory reports of the direction of flight in various previous accounts of migration, and states that he has discovered the solution, which is that there is a reversal of direction during the day. In the case he describes the butterflies were flying along a branch of the River Amazon from north to south during the morning and from south to north during the afternoon, the reversal being quite regular each day. There is no reason to doubt for a moment his observations, and I have noticed a somewhat similar occurrence in the migration of a Hesperid butterfly in Panama, which I hope to describe later, but in the migration of *Catopsilia statira* at present under consideration there is no evidence to prove that this was happening.

It must be admitted that throughout the migration there were heavy rains nearly every afternoon, and usually the migration for the day ceased when these began, but on the few fine afternoons, and occasionally after the rains, the direction of flight when recorded was nearly always similar to the regular direction of the morning.

The flight for the day usually started at 9.30 a.m. or even a little later, but I have several records as early as 8 a.m. and in two cases at 7 a.m. There is slight evidence of change of direction one day at San Fernando (1.x.), when the flight was towards the north-west in the morning and towards the south-west in the afternoon after the rains, but this could scarcely be classed as a reversal of direction. On the other hand, the flights from west to east that are recorded from Port of Spain district on the 28th, 29th, 30th September, and 2nd and 3rd October, do not appear to have been in any way connected with the time of day.

In cases where the migration is very thin and the butterflies are only passing at intervals, the direction of flight of one butterfly is not likely to influence directly that of another. But when the flight is more dense this may happen, and the following observation may be of interest in this connection.

On the 27th September the butterflies were passing at the rate of 50 to 100 per minute across a hundred yards line over the Savannah in Port of Spain about 1 p.m. I went out with a net in order to catch specimens for the determina-

tion of the species and the sex proportions. The butterflies were flying so fast that they were not easy to catch, and many more escaped than were captured. I then noticed that any butterfly narrowly missed was put off its direction by the excitement and flew off wildly in any direction. Other butterflies close at hand meeting this butterfly flying out of the general order would in turn become confused and sometimes follow it in its new direction. So that after several misses in succession I was surrounded by a number of butterflies flying in all directions. If I stopped attempting to catch specimens these would gradually pass away, and the regular direction of flight would be resumed.

Proportion of Sexes.

The following actual figures were obtained for catches :—

Port of Spain, end of Sept.	5	females,	1	male	(T. I. Potter).
Port of Spain, 27th Sept.	9	,,	10	males	(C. B. W.).
Palmisti (S. of San F'do), 30th Sept.	5	,,	4	,,	(Norman Lamont).
La Brea, 4th Oct.	6	,,	4	,,	(Dr. Rodriguez).

From these it might be supposed that the sexes were in more or less equal proportions, but I am not convinced that this was so in the actual flights. All the above records suffer from the fact that the females are much more easy to catch than the males, and in addition, in certain cases, I believe the specimens were caught not actually on migration, but stopping to flutter around flowers on the way. It is quite likely that this habit would be found more in the females, with eggs to mature, than in the males.

At the time I collected the nineteen specimens mentioned above I found that I could, with difficulty, distinguish the females from the males in flight, and estimated the proportion as approximately 1 female to 10 males.

Density of Migration and Effects of Sunshine.

It will be seen from the records in the maps that the numbers passing varied from two or three occasional specimens to a cloud so dense as to interfere with the progress of a motor-car. Perhaps an even better idea of their occasional abundance is obtained from one record in which they were stated to be passing over a house in the country in such immense numbers that the turkeys in the garden looked up at them and gobbled in consternation !

More usual than this was an open order in which the butterflies hurried past, each individual more or less equally separated from its neighbours, some close to the ground, some as high as twenty feet, but by far the greater number at from 4 to 10 feet from the ground or other surface (sea, or tree-tops) over which they were flying.

The flight was almost always in bright sunshine, and whenever a cloud passed over the sun there was an immediate drop in the numbers passing. As the butterflies were not flying at the same speed as the cloud shadows, flying faster than the wind when with it, and often across it or against it, it is difficult to understand the rapid reduction. The same effect was noticed in the case of *Callidryas eubule* in British Guiana.

It is possible that in the absence of the sun the individuals fly more slowly or flutter round waiting for the sun to reappear, so that fewer would cross a given line in the same time. If this were so, there should be a rush of those individuals held up, on the return of the sun. No detailed observations were made on this point at the time, but I do not recollect any effect of this type.

Food-Plants.

The food-plant of *Catopsilia statira* is not definitely known in Trinidad. It is almost certainly some forest leguminous tree, and W. Potter says that he believes it to be a species of *Cassia* or *Mimosa*. Goeldi (*l.c.*, p. 315) describes a forest tree, *Vouapa acaciaefolia*, Baillon, or *Macrolobium acaciaefolium*, Bentham, as a possible food-plant in Brazil, as he had observed numerous butterflies leaving the general migration and fluttering round this tree (see below).

While on migration the majority of the butterflies do not stop to visit flowers which they pass on the way, but occasional individuals (mostly females) may do so, and between the movements they are abundant flying round the flowers of *Hibiscus*, Pommearack (*Eugenia malaccensis*), *Eupatorium odoratum*, Black sage (*Lantana* sp.), Guimauve or Wild Ochroe (*Malacra capitata*), and many others.

Resting in Patches on the Ground.

As in many previously recorded migrations the adult butterflies, when not migrating, were frequently found

resting in large patches on the roads. Most of the records from the south-eastern portion of the island are of such patches disturbed by passing cars. The groups may contain from a hundred or less to several thousand individuals, and are described in some records as appearing in the distance like large patches of yellow-green grass.

The butterflies are sometimes congregated round moist patches on the road, but in other cases the spots they have chosen do not appear on casual observation to differ in any way from the rest of the road. It may be that it is only the gregarious habit of the butterfly that has led them to congregate, but it is more likely that the patches chosen are where urine from animals passing along the road has recently dried up, and that the butterflies are obtaining some kind of nutriment from the dried salts (in this connection see discussion in Proc. Ent. Soc. London, 1917, p. lxxvii).

Previous Migrations of Yellow Butterflies in Trinidad.

It might be convenient to add here for completeness a few records I have obtained of previous migrations in Trinidad. It must be noted that in these cases no specimens are available for comparison, so that it cannot be said for certain whether the species was *Catopsilia statira* or *Callidryas eubule.*

(1) Mr. Guy Gray, living at Matura on the east coast, adds to his records of the present migration—" I have seen these butterflies, I think, every year, but not at the same time."

(2) Walter Potter states that *Catopsilia statira* swarms nearly every year somewhere in the Island.

(3) Cecil Rostant of Moruga (south coast) in reply to an inquiry for information on the present migration replied that they were flying " in the usual direction." Later he explained that this was from east to west, and that they flew in this direction nearly every year in his district.

(4) W. Buthn of the Department of Agriculture states that he saw small numbers of yellow butterflies flying towards the east in Port of Spain in 1916 about August.

(5) Mr. T. I. Potter reports a large swarm of probably *Catopsilia statira* flying over the Savannah in Port of Spain in 1915 from east to west. They were not so common as the present (1918) migration, nor did they last so long.

(6) Mr. Roebottom reports that at Cedros (south-western promontory) in 1916 yellow butterflies were flying towards the east for about four days in large numbers. He is not sure of the month, but thinks that it was towards the end of the dry season (April or May) as the local explanation of the flight was that the butterflies were looking for water.

Note.—Since the above was written Mr. W. Potter tells me that he has seen *Catopsilia statira* ovipositing on the leaves of " Bois Mulàtre " (*Pentaclethra filamentosa*), which is a common leguminous forest tree in Trinidad.